別紙様式第３号　　No.

博 士 論 文 内 容 の 要 旨

専攻名　物質工学専攻

講座名　分子工学講座

氏　名　于洁

１　論文題目（英文の場合は，和訳を付記すること）

Electrochemical movement of an oil drop on the electrode

（電極上の油滴の電気化学的な動き）

２　要　　旨（和文 2,000 字程度又は英文 800 語程度にまとめること。）

The research on expansion and contraction of oil-sessile drop motion is applied on display elements and focus-tunable lenses. The mechanism is based on electrocapillarity which is a phenomenon of varying a contact angle of a sessile drop on an electrode with electrode voltage. The high driving voltage and short lifetime of the dielectric layer are the disadvantages. If electrode reaction which is driven by low voltages causes electrowetting, it can overcome the disadvantages. The aim of this thesis is to investigate whether the oil sessile drop motion could be controlled by electrochemical reaction of emulsion.

There are six chapters in this thesis. The Chapter 1 is devoted to the background of this study along with its present status and our aim of future futurity as well. The Chapter 2 describes the experimental procedures. Chapters 3, 4 and 5 study on the emulsification at water|oil interface, controlling surfactant by electrochemical reaction of emulsion, and application of the oil droplet motion, respectively.

The chapter 3 is devoted to detect the emulsification at water|nitrobenzene (NB) interface by electrochemical reaction. A pyrolytic graphite electrode (PGE) which has been coated with 30 μm thick NB film is immersed in hexacyanoferrate-included aqueous solution for thin-layer cell voltammetry. The reduction wave of ferricyanide appears at high scan rates. The water-soluble redox species, ferricyanide is demonstrated to pass through the nitrobenzene film in the form of aqueous droplets, which are adsorbed on the electrode surface. The large amount of adsorbed ferricyanide (the surface area of $(1\ nm)^2$ per adsorbed molecule) also has been calculated. Formation of aqueous droplets can explain electrode reactions at carbon paste electrodes without

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including redox species in paste.

The chapter 4 is devoted to control the water|NB interfacial tension by using the adsorbed ferricyanide. The ionic surfactant tetrapentylammonium (TPA^+) chloride is used as supporting electrolyte in both aqueous and NB phase. A hemispherical NB drop has been injected on the center of the PGE, then immerse it in aqueous phase. The NB drop on the PGE expands in shape at the oxidation, whereas it contracts at the reduction of emulsions. The motion can be explained in terms of the interplay of the surface tension at the interface of NB|PGE and adsorption of ferricyanide in the NB phase on the PGE. The density of the adsorption is of the order of 10^{-10} mol cm^{-2}, which corresponds to 2 mol dm^{-3} (=M) for bulk concentration. The redox reaction varies concentrations of TPA^+ by 2 M near the electrode. The large concentration variation alters surface energy, yielding the motion accompanied by voltammetry.

The chapter 5 is an application based on this electrochemical mechanism in chapter 4. A sessile drop of NB mounted on the transparent electrode immersed in the aqueous solution works as an optical lens of which focus can be controlled by electrode potential. The focal length decreases in the reduction potential domain. The focal length at the oxidation potential was 2.5 times larger than that at the reduction one. The switching between the long and the short focuses is almost reversible for 1 hour by the potential control, synchronized with voltammograms.

Conclusions of this thesis are shown in chapter 6.